SYNOPSIS

Ph.D. in Physical Education

ISOLATED AND COMBINED EFFECT OF SPEED, AGILITY AND QUICKNESS TRAINING AND RESISTANCE TRAINING ON SELECTED PSYCHOMOTOR AND PHYSIOLOGICAL VARIABLES AMONG SPRINTERS

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INTRODUCTION

Sports are not just about physical activity and competition; they have a profound impact on society by promoting physical and mental health, fostering social integration, contributing to the economy, and influencing cultural and societal norms. The sport is a carrier, which encourages coaching of various sports and games along with rules and regulations governed by them and also it prepares the trainees to take active part in competitive sports. It grows out of man's struggle for survival in a hostile world **(Baechle, T. R., & Earle, R. W. 2019).** The integration of science and technology into sports training and performance has revolutionized the way athletes prepare and compete through scientifically substantiated training methods, sports techniques and tactics**,** improvement of sports surfaces, equipment advancements, sports science research, conditioning and rehabilitation, integration of technology, etc., These advancements have not only improved athletes' physical capabilities but have also enhanced their understanding of the sports they participate in, leading to more strategic and effective performances **(Birhanu, Z., & Mesfin, R. 2017).**

Training is essential for two fundamental reasons, to provide individuals with the knowledge and skills required to effectively utilize the performance appraisal system **(MacLean, J. 2001)**. Athletic training is a structured and long-term process that involves progressively increasing the demands on an athlete's body to elicit positive adaptations. These adaptations can lead to improved athletic performance, but it's essential to balance training with rest and recovery to ensure the best results and minimize the risk of injuries. Sports training are a dynamic and evolving field, constantly adapting to new scientific insights and technological advancements to help athletes reach full potential and achieve remarkable athletic feats. It is a systematic process aimed at enhancing an athlete's mental and physical capabilities, as well as the motivation, with the goal of achieving exceptional and record-breaking athletic performances. This process relies on the application of scientific principles to optimize training methods and strategies.

SAQ training is indeed a system of progressive exercises and instructions designed to enhance an athlete's fundamental motor skills. The primary goal of SAQ training is to improve an athlete's ability to perform at faster speeds and with greater precision (Azmi, K., & Kusnanik, N. W. 2018). Resistance training is a versatile form of exercise where force or stationary weights are used to enhance muscular strength, endurance, power, and indirectly improve skills related to

various activities. It's essential to tailor the resistance training program to the specific goals and abilities while ensuring proper technique and safety precautions. Combined training in sports training refers to a holistic approach that combines different training methods and elements to enhance an athlete's performance. This approach recognizes that sports training should not focus on just one aspect but should incorporate a variety of components to achieve optimal results [D1]. In the present study, SAQ training and resistance training were used as a combined training method. These two training methods were combined, to done with the goal of enhancing overall athletic performance.

Motor skill performance is a complex interplay of neural, physiological, and psychological factors, and it's not solely a physical or mental response. Successful performance often relies on the seamless integration of these aspects, allowing individuals to execute precise and coordinated movements in various activities. It is a complex process that goes beyond just physical or mental responses. Natural factors like height, atmosphere, temperature, humidity, and nutritional status can impact an athlete's performance, particularly in relation to the physiological systems of the body. These factors will have a significant influence on an athlete's performance, and they interact with the body's circulatory, respiratory, metabolic, and neurologic processes in unique ways depending on the specific activity (Kaloy, S. 2007).

Need for the Study

The study on the isolated and combined effects of SAQ training and resistance training on selected psychomotor and physiological variables among sprinters serves several purposes that includes performance Enhancement, injury prevention, training efficiency, psychomotor skill development, individualization of training, scientific advancement, etc., Overall the study provides valuable insights that can benefit sprinters and their coaches in their pursuit of excellence.

Statement of the Problem

The purpose of the study was to investigate the isolated and combined effects of SAQ training and resistance training on selected psychomotor and physiological variables among sprinters. This research can provide valuable insights into how different training methods impact athletes' performance and physical characteristics.

Objectives of the Study

The main research objectives are:

- Assess the isolated and combined effects of Speed, Agility, and Quickness (SAQ) training and Resistance Training on specific psychomotor and physiological variables among sprinters.
- Implement three different training capsules for selected experimental groups to enhance the speed training determinants among sprinters.
- Arbitrate which training capsule yields the most substantial improvements in the targeted variables among the selected groups.

Research gap

- Existing researches focuses more on isolated effects rather than their combined influence
- Specific speed determinants must be explored or adequately studied within SAQ and Resistance Training for sprinters. This gap could lead to a more refined investigation
- Most of the Studies individually assess the effectiveness of each training capsule. However, limited research directly compares the capsules to determine which yields the most substantial improvements in the targeted variables
- Despite the voluminous body of research devoted to sports training to sprint training, understanding the training process leading to cutting-edge performance is limited!

Research Questions

- How do selected psychomotor and physiological variables respond to SAQ, resistance, and combined training capsules among sprinters?
- What extent does the selected psychomotor and physiological variables influenced by the outcomes of both standalone and integrated SAQ and resistance training interventions?
- How can the isolated and combined training impact on selected psychomotor and physiological variables be leveraged to improve sprinting performance?

Delimitation

The study was delimited to the following factors:

- Sixty inter collegiate participants were chosen across nine collegiate educational institutions in the Coimbatore district
- Athletes falling between the age range of 18-23 years
- Study was restricted to the female athletes
- Only selected psychomotor and physiological variables were studied

Limitations

The study was limited to the following aspects:

- Food habits
- Daily routine
- Socio economic status
- Life style
- Supervisors individuality at various training venues
- Extraneous factors (Environmental and Climatic Condition, study major, etc.,)

Hypotheses

It was hypothesized that,

- Twelve weeks of SAQ training may improve the selected psychomotor and physiological variables among sprinters.
- Twelve weeks of resistance training may improve the selected psychomotor and physiological variables among sprinters.
- Twelve weeks of combined training may improve the selected psychomotor and physiological variables among sprinters.
- There may be a significant difference exist among SAQ training group, resistance training group and combined training group on the selected psychomotor and physiological variables among sprinters.
- Combined training may have greater improvement than SAQ and resistance training on selected psychomotor and physiological variables among sprinters.

Significance of the Study

Physical educationists and sport scientists examine sports performance in relation to individual skill and fitness standards, with the aim of improving coaching and training. The present study may contribute as under:

- Provide valuable insights into optimizing training programs for sprinters to enhance their sprinting capabilities to competitive edge
- Studying the isolated and combined effects of two or three trainings can lead to strategies that harmoniously integrate muscular strength with speed related attributes, optimize overall sprinting abilities
- Research can help coaches, trainers and athletes make informed decisions about structuring training programs to achieve maximal performance gains in sprinting while addressing varied aspects of sports

CHAPTER - 2
REVIEW OF RELATED LITERATURE

The review of related literature is an essential component of research endeavor. It serves as the foundation upon which a research study is built, providing a comprehensive overview of existing knowledge, theories, and research findings relevant to the topic under investigation. The review of related literature aims to identify, analyze, and synthesize existing literature, highlighting the gaps, controversies, and unresolved questions that justify the need for the current study.

The study by Azmi, K., & Kusnanik, N. W. (2018) investigated the effect of a speed, agility, and quickness (SAQ) exercise program on improving speed, agility, and acceleration in athletes. There was a significant improvement in the speed and agility of the athletes after the six-week of training program. The athletes also showed a significant improvement in their acceleration, as measured by the 10-meter sprint time.

The study by Sporis., et al. (2011) investigated the effects of a strength training program on the aerobic and anaerobic power of female soccer players. The results showed that the STG had significant improvements in both aerobic and anaerobic power compared to the CG. Specifically, the STG showed a 6.9% increase in VO2max and a 7.2% increase in peak power output during the Wingate test. The study concludes that a 10-week strength training program can improve both aerobic and anaerobic power in female soccer players.

The study conducted by Kobal, R., et al. (2017) aimed to investigate the effects of different combinations of strength, power, and plyometric training on the physical performance of elite young soccer players. The researchers recruited 33 male soccer players from a Brazilian soccer club and randomly assigned them to one of four groups: strength training (ST), power training (PT), plyometric training (PLY), or a combination of all three (CMB). The training intervention lasted for 12 weeks, with two to three training sessions per week. The results showed that all four groups significantly improved their physical performance measures, including vertical jump height, sprint times, and agility. However, there were no significant differences between the groups in terms of the magnitude of improvement.

CHAPTER 3

METHODOLOGY

Research methodology is a scientific and systematic way to solve the research problem (Blessing, L. T., et al. 1995). Research methods helps rule out the influencing factors which are to affect the investigation in a professional and complex way. It has to be conducted through a correct and reliable process (Dzwigol, H., & Dzwigol-Barosz, M. 2018). In short, the search for knowledge through objective and systematic method to derive solution to a problem is research (Kothari, C, R. 2004).

Selection of participants

A meeting was conducted with women sprinters of the Coimbatore district on the eve of an open district championship asking for consent towards participation in this research work. Initially readiness for participating in the study was collected from hundred women sprinters through PAR-Q (Physical Activity Readiness Questionnaire) a self-administered screening tool (Warburton, D. E., et al. 2011). Seventy nine collegiate women sprinters across nine collegiate educational institutions in the Coimbatore district were qualified and accepted to participate in the study. After the initial performance analysis (pretest) on the selected psychomotor and physiological parameters, five sprinters with extreme high and low performance were eliminated to ensure normality. Remaining seventy four female intercollegiate level sprinters falling between the age ranges 18-23 were chosen for the study. Informed consent was obtained from all participants.

Selection of Variables

Independent variable

- SAQ training
- Resistance training
- Combined SAQ & resistance training

Outcome variable and criterion measures

Psychomotor variables

Outcome variable	Tests	Unit of measurement
Reaction time	Purdue pegboard test	Count in numbers
Speed	50 m dash	In Seconds
Coordination	Stick flip coordination test	In points
Explosive power	Vertical jump test (Sargent jump)	In Centimeter

Physiological variables

Outcome variable	Tests	Unit of measurement
Resting pulse rate	Radial artery method	Beats per minute
Muscle strength	Hand grip dynamometer	In Kilogram
Anaerobic power	Margaria-Kalamen power test	Power in watt
Oxygen saturation	Pulse oximetery test	In percentage

Reliability

Competency of the tester

The present study that investigates the isolated and combined effects of SAQ training, resistance training, and combined training, was carried out by the researcher, with the support of physical trainers and coaches. It was ensured that the researchers' assistants were proficient in conducting training sessions and had reliable testing methods through a test and retest approach (Bohannon, R. W. 1986).

Reliability of instruments

Instruments used in the study are reliable and were considered accurate enough for the purpose of the research.

Reliability of the data

The reliability of the data was established three months before the commencement of the experimental research using fifteen athletes randomly. To ensure reliability of the data the test-retest method was used. The training participants were tested two times per day. Adequate interval between the tests was given and after one day interval the same tests were again administered twice for all the selected outcome variables. The Intra-class coefficient of correlation was used to assess the degree of similarity between multiple observations taken on the same subjects. Since the obtained 'r' values were higher than the required value (0.77 at 0.01 level of confidence) the data were accepted as reliable in terms of instrument, tester and the subjects.

Execution of the test and training

Orientation to the participants and ethical clearance

A meeting was conducted with women sprinters of the Coimbatore district on the eve of an open district championship. An approval was obtained from the Institutional Human Ethics Committee of Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, Tamil Nadu, India for involving human subjects. Written consent was obtained from the participants to participate in the experiment according to the principles outlined in the declaration. Before collection of the data, participants were oriented about the purpose of research, their role and commitment expectancy over them till the end of this research process.

Pilot study

A pilot study was conducted for a period of four weeks (In J., 2017) to assess the initial capacity of the participants, to fix the load, to select the exercises and to design the training programme (Hassan, Z. A., 2006). Fifteen intercollegiate women sprinters were selected and were randomly assigned to one of the SAQ training, resistance training, and combined training groups. Participants involved in the pilot study were excluded from the main research. Modified adapted training modality was executed in the pilot study.

Grouping the samples

Selected seventy four athletes were divided into four groups using random sampling technique as mentioned below:

Experimental group 1	- SAQ Training group (n=18) - SAQT group
Experimental group 2	- Resistance Training group (n=18) - RT group
Experimental group 3	- Combined SAQ and Resistance Training group (n=19) - SAQRT group
Control group	- No specific training other than their regular training (n=19) CG

Finally post test was conducted for fifteen subjects in all groups leaving away the irregular athletes, absentees, injured and sick.

Data collection

The data on psychomotor and physiological variables were collected from sixty women sprinters. All the participants were tested prior to training and post test was conducted after 12 weeks on the completion of the experimentation. In both the cases, data were collected for the duration of two days as the dependent variables were more in number. All the tests were conducted during the morning and evening sessions.

Research design

Randomized Controlled Design (RCT) was administered in the present study. Samples were randomly assigned to different groups, typically an experimental groups received the treatments and a control group received a placebo or standard treatment (Ebbeling, C. B., 2012).

Training programme

Subjects were assigned to different groups and underwent specific training programs over a period of 12 weeks. The training program was conducted on Monday, Wednesday, and Friday in the morning sessions from 6.30 am to 8.30 am. Each exercise session lasted 60 minutes. The entire training program, including warm-up and warm-down exercises, lasted a total of 120 minutes. Hence, the subjects involved in the study randomly fell at 9 colleges across the

Coimbatore district they were pooled at two training venues. Two additional instructors were involved to conduct parallel training sessions at both venues. The researcher supervised the training programs and alternated between the two locations on different days.

Load Dynamics

In the present study, exercise difficulty and intensity of the training programs were gradually increased over twelve week period. The programs have been structured in a way that started with basic exercises and progressed to more advanced ones, and this progression was done over the course of twelve weeks. The first phase of four weeks focused on easier exercises and then the difficulty was gradually increased in the following two phases of four weeks.

Statistical techniques

Statistical methods used in the study involve paired sample t-tests, Analysis of Covariance (ANCOVA), and Scheffe's post-hoc test. Paired sample 't' test was used to determine if there are significant mean differences exists between pre and post test on each chosen dependent variable in both control and experimental groups. Analysis of Covariance (ANCOVA) was used to find if there are significant difference exists amongst the three experimental groups and control group. The Scheffe's post-hoc test was employed to identify which paired means differ significantly if there's a significant difference detected through ANCOVA. The significance level for hypothesis testing was set at 0.05. The software used for the statistical analysis was the trial version of SPSS.

Chapter 4

ANALYSIS AND INTERPRETATIONS OF THE DATA

Data interpretation involves making sense of the information collected by examining it, drawing conclusions, and deriving meaningful insights to inform decision-making about a particular problem (Brown, L. 2010). It necessitates identifying recurring trends and condensing the pertinent information uncovered during the investigation. The choice of an analytical technique for data analysis depends on the research design and the nature of the collected data (Zikmund, W. G., et al. 2003).

Discussion on findings

The statistical results shows that there was a significant improvement between pre test and post test mean among sprinters on reaction time, speed, coordination, explosive power, resting pulse rate, muscle strength, anaerobic power and oxygen saturation due to the impact of 12 weeks of SAQ Training. The obtained t-test value of reaction time was 31.55, speed was 25.52, coordination was 19.14, explosive power was 30.94, resting pulse rate was 11.30, muscle strength was 20.55, anaerobic power was 506.42 and oxygen saturation was 5.00 which were greater than the required table value 2.14 at df 14.

The statistical results shows that there was a significant improvement between pre test and post test mean among sprinters on reaction time, speed, coordination, explosive power, resting pulse rate, muscle strength, anaerobic power and oxygen saturation due to the impact of 12 weeks of resistance training. The obtained t-test value of reaction time was 38.91, speed was 57.70, coordination was 2.23, explosive power was 95.31, resting pulse rate was 39.29, muscle strength was 45.50, anaerobic power was 186.49 and oxygen saturation was 11.00 which were greater than the required table value 2.14 at df 14.

The statistical results shows that there was a significant improvement between pre test and post test mean among sprinters on reaction time, speed, coordination, explosive power, resting pulse rate, muscle strength, anaerobic power and oxygen saturation due to the impact of 12 weeks of combined training. The obtained t-test value of reaction time was 74.61, speed was 11.02, coordination was 11.74, explosive power was 64.43, resting pulse rate was 28.37, muscle strength was 11.46, anaerobic power was 97.20 and oxygen saturation was 14.79.

The statistical results shows that there was no significant improvement found between pre test and post test mean among sprinters on reaction time, speed, coordination, explosive power, resting pulse rate, muscle strength, anaerobic power and oxygen saturation in control group. The obtained t-test value of reaction time was 0.807, speed was 0.807, coordination was 1.00, explosive power was 0.65, resting pulse rate was 2.10, muscle strength was 2.09, anaerobic power was 1.45 and oxygen saturation was 1.17 which were greater than the required table value 2.14 at df 14.

The statistical results shows that there was a significant difference exists among SAQ training group, resistance training group, combined training group, and control group on reaction time, speed, coordination, explosive power, resting pulse rate, muscle strength, anaerobic power and oxygen saturation. The F-ratio value among SAQ training group, resistance training group, combined training group and control group. The obtained F-ratio on reaction time was 527.97, speed was 68.93, coordination was 38.56, explosive power was 1120.98, resting pulse rate was 159.38, muscle strength is 107.3, anaerobic power was 7599.55 and oxygen saturation was 13.89 which were greater than the required table value 2.77 at df 3,55

By administering Scheffe's post-hoc test it was inferred that combined training group shows better improvement on reaction time, speed, coordination, explosive power, resting pulse rate, and Oxygen Saturation than SAQ training group and resistance training group among sprinters.

The statistical results show that there was no difference found between SAQ training group and resistance training on improving speed. However, no significant difference exists between control group and resistance training group in coordination. Resistance training group shows predominant improvement in muscle strength and no difference was found in the improvement in muscle strength between SAQ training group and combined training group. SAQ training group has exerts distinct influence on anaerobic power. No difference in the improvement was found between the experimental groups in oxygen saturation.

The obtained results of the present study were also supported by the previous conducted studies. According to Amany, I., & Gehad, N. (2017) SAQ training improves the reaction time & acceleration. Azmi, K., & Kusnanik, N. W. (2018) reveals that SAQ training has significant impact on speed and acceleration. Khan, D. J. A. A., & Sevi, R. (2016) found that SAQ training

has a positive impact on physiological variables among university men. Simons, R., & Andel, R. (2006) found that resistance training has good knock in resting pulse rate. Bloomer, R. J., et al. (2010) compares the pre-workout nitric oxide stimulating dietary supplements on skeletal muscle oxygen saturation, blood nitrate/nitrite, lipid peroxidation, and upper body exercise performance in resistance trained men and found positive effect.

Discussion on hypotheses

Hypothesis 1

It was hypothesized that, 12 weeks of SAQ training may improve the selected psychomotor and physiological variables among Sprinters.

The statistical result of the present study shows significant improvement exist between pre test and post test mean on selected psychomotor and physiological variables among sprinters due to the impact of 12 weeks SAQ training. Hence first hypothesis was accepted at 0.05 level of significance.

Hypothesis 2

It was hypothesized that, 12 weeks of resistance training may improve the selected psychomotor and physiological variables among sprinters.

The statistical result of the present study shows significant improvement exist between pre test and post test mean on selected psychomotor and physiological variables among sprinters due to the impact of 12 weeks of resistance training. Hence second hypothesis was accepted at 0.05 level of significance.

Hypothesis 3

It was hypothesized that, 12 weeks of combined training may improve the selected psychomotor and physiological variables among sprinters.

The statistical result of the present study shows significant improvement exist between pre test and post test mean on selected psychomotor and physiological variables among sprinters due to the impact of 12 weeks of combined training. Hence third hypothesis was accepted at 0.05 level of significance.

Hypothesis 4

It was hypothesized that, there may be a significant difference exist among SAQ training group, resistance training group and combined training group on the selected psychomotor and physiological variables among sprinters.

The statistical result of the present study shows that there was a significant difference exists among SAQ training group, resistance training group and combined training group on the selected psychomotor and physiological variables among sprinters. Hence fourth hypothesis was accepted at 0.05 level of significance.

Hypothesis 5

It was hypothesized that, combined training may have greater improvement than SAQ and resistance training on selected psychomotor and physiological variables among sprinters.

The statistical result of the present study shows that the combined training have greater improvement than SAQ training group, and resistance training group on the selected psychomotor and physiological variables among sprinters. Hence fifth hypothesis was accepted at 0.05 level of significance.

Chapter 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

This chapter encompasses the conclusion and proposes avenues for future investigation. To accomplish the study's objectives, a sample of sixty (n=60) women sprinters aged 18-23 was recruited. An event was organized with women sprinters of the Coimbatore district on the eve of an open district championship to seek their consent for their participation in the research study. Women sprinters from nine collegiate educational institutions in the Coimbatore district agreed to take part in the research study. Using PAR-Q (Physical Activity Readiness Questionnaire) a self-administered screening tool (Warburton, D. E., et al. 2011) seventy nine out of hundred women intercollegiate level sprinters met the criteria and were subsequently chosen for the initial performance analysis on the selected psychomotor and physiological parameters. Subsequent to the pre-test evaluations, five sprinters demonstrating extreme and subpar performance were eliminated from the study to uphold the assumption of normality. Remaining seventy four participants who were selected have provided their informed consent before participation. Post test was conducted with 15 subjects in each group, excluding individuals with irregularities and those who were unwell.

The participants in the study were randomly assigned to one of the four groups. Group I – SAQ training group (n=18); Group II – resistance training group (n=18); Group III – combined training group (n=19) which includes elements of both SAQ and resistance training; Group IV – control group (n=19) did not participate in any vigorous activity and were used as a baseline for comparison. Independent variables chosen for the study involve SAQ training, resistance training, and combined SAQ and resistance training. These variables were manipulated to investigate their effects on selected dependent variables. Outcome variables measured in the study were psychomotor variables comprises of reaction time, speed, coordination, and explosive power. Physiological variables contain resting pulse rate, muscle strength, anaerobic power, and oxygen saturation. The training intervention was conducted over a span of twelve weeks, occurring on three non-consecutive days each week.

Statistical methods used in the study involve paired sample t-tests, Analysis of Covariance (ANCOVA), and Scheffe's post-hoc test. Paired sample 't' test was used to determine if there are significant mean differences exists between pre and post test on each chosen dependent variable in both control and experimental groups. Analysis of Covariance (ANCOVA) was used to find if there are significant difference exists amongst the three experimental groups and control group. The Scheffe's post-hoc test was employed to identify which paired means differ significantly if there's a significant difference detected through ANCOVA. The significance level for hypothesis testing was set at 0.05. The software used for the statistical analysis was the trial version of SPSS.

Conclusion

The following conclusions were drawn from the statistical results of the study.

- Demonstrated that both isolated training capsules exert distinct influences on sprinters performance, with SAQ training enhancing specific anaerobic power , and resistance training predominantly influencing muscle strength
- Combined approach showcased a synergistic effect, highlighting the potential increase in reaction time, speed, co-ordination, explosive power, resting pulse rate and oxygen saturation including muscle strength and anaerobic power that addresses multiple facets of sprinting prowess

Ultimately, the pursuit of athletic excellence thrives on such advancements; drive both science and practice towards ever greater achievements on the track and beyond

Recommendations

- Diversified training protocols: Encourage coaches and trainers to incorporate diversified training protocols and training capsules on the selected variable
- Individualized training plans – Not all sprinters will respond the same way to the combined training. Personalized plans that consider each athlete's baseline fitness, strengths, weaknesses, and goals can optimize their progress

- Monitoring and tracking - Utilize technology and data analysis to assess the impact of the training regimen on the selected variables. This data-driven approach can provide valuable insights into the effectiveness of the training program
- Holistic approach to athlete development - Beyond physical training, incorporate elements such as mental conditioning, nutrition, and recovery strategies to ensure overall well-being and enhanced performance
- Research-practice integration - Coaches and trainers can stay updated with the latest scientific studies and adapt the latest training methods. This promotes evidence-based training and contributes to the advancement of the field.

References

Amany, I., & Gehad, N. (2017). Influence of SAQ training on reaction time of 100 sprint start and block acceleration. *Ovidius University Annals, Series Physical Education & Sport/Science, Movement & Health*, *17*(1).

Azmi, K., & Kusnanik, N. W. (2018). Effect of exercise program Speed, Agility, and Quickness (SAQ) in improving speed, agility, and acceleration. In *Journal of Physics: Conference Series* (Vol. 947, No. 1, p. 012043). IOP Publishing.

Baechle, T. R., & Earle, R. W. (2019). *Weight training: steps to success*. Human Kinetics.

Birhanu, Z., & Mesfin, R. (2017). The association between anthropometric, physiologic and physical fitness variables with 5000m running performance for junior female athletes.International Journal of Physiology, Nutrition and Physical Education 2017; 2(1): 162-166.

Blessing, L. T., Chakrabarti, A., & Wallace, K. (1995). A design research methodology. In *Proc. International Conference on Engineering Design 1995 ICED* (pp. 50-55).

Bloomer, R. J., Farney, T. M., Trepanowski, J. F., McCarthy, C. G., Canale, R. E., & Schilling, B. K. (2010). Comparison of pre-workout nitric oxide stimulating dietary supplements on skeletal muscle oxygen saturation, blood nitrate/nitrite, lipid peroxidation, and upper body exercise performance in resistance trained men. *Journal of the international society of sports nutrition*, *7*(1), 1-15.

Bohannon, R. W. (1986). Test-retest reliability of hand-held dynamometry during a single session of strength assessment. Physical therapy, 66(2), 206-209.

Brown, L. (2010). Quasi-experimental research. Doing Early Childhood Research: International perspectives on theory and practice, 345

Dzwigol, H., & Dzwigol-Barosz, M. (2018). Scientific research methodology in management sciences. *Financial and credit activity problems of theory and practice*, *2*(25), 424-437.

Ebbeling, C. B., Feldman, H. A., Chomitz, V. R., Antonelli, T. A., Gortmaker, S. L., Osganian, S. K., & Ludwig, D. S. (2012). A randomized trial of sugar-sweetened beverages and adolescent body weight. *New England Journal of Medicine*, *367*(15), 1407-1416.

Hassan, Z. A., Schattner, P., & Mazza, D. (2006). Doing a pilot study: why is it essential?. *Malaysian family physician: the official journal of the Academy of Family Physicians of Malaysia*, *1*(2-3), 70.

In J. (2017). Introduction of a pilot study. *Korean journal of anesthesiology*, *70*(6), 601–605. https://doi.org/10.4097/kjae.2017.70.6.601

Khan, D. J. A. A., & Sevi, R. (2016). Effect of SAQ training on selected physiological parameters among university men students. *International Journal of Physical Education, Sports and Health*, *3*(6), 119-21.

Kobal, R., Loturco, I., Barroso, R., Gil, S., Cuniyochi, R., Ugrinowitsch, C., ... & Tricoli, V. (2017). Effects of different combinations of strength, power, and plyometric training on the physical performance of elite young soccer players. *The journal of strength & conditioning research*, *31*(6), 1468-1476.

Kothari, C. R. (2004). *Research methodology: Methods and techniques*. New Age International.

MacLean, J. (2001). *Performance appraisal for sport and recreation managers*. Human Kinetics.

Simons, R., & Andel, R. (2006). The effects of resistance training and walking on functional fitness in advanced old age. *Journal of aging and health*, *18*(1), 91-105.

Sporis, G., Jovanovic, M., Krakan, I., & Fiorentini, F. (2011). Effects of strength training on aerobic and anaerobic power in female soccer players. *Sport science*, *4*(2), 32-37.

Warburton, D. E., Jamnik, V. K., Bredin, S. S., & Gledhill, N. (2011). The physical activity readiness questionnaire for everyone (PAR-Q+) and electronic physical activity readiness medical examination (ePARmed-X+). *The Health & Fitness Journal of Canada*, *4*(2), 3-17.

Zikmund, W. G., Babin, B. J., Carr, J. C., & Griffin, M. (2003); Business research methods 7th ed. Thomson/South-Western

Web links:

https://nwpersonaltraining.com/blog/combination-training/